May 21, 2020

VERMONT PUBLIC SERVICE DEPARTMENT

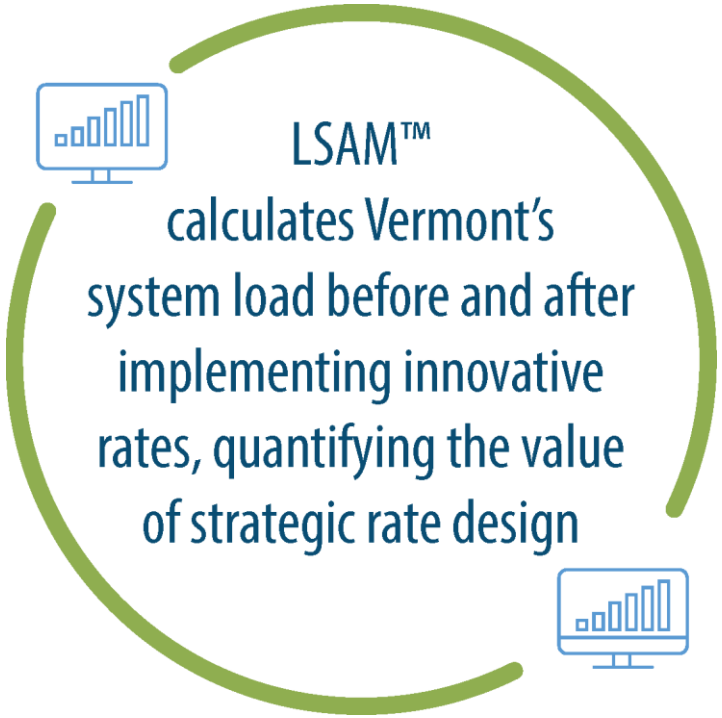
RATE DESIGN INITIATIVE / DISTRIBUTED ENERGY RESOURCES STUDY
STAKEHOLDER ENGAGEMENT MEETING #4

NewGen Strategies & Solutions

VERMONT RATE DESIGN INITIATIVE

LSAM™ AND THE VT RATE DESIGN INITIATIVE

- LSAM™ allows iteration of input assumptions to evaluate many future states of the electric market in Vermont
  - Future electric usage will vary vis-à-vis market forces, decarbonization, and technology adoption
- LSAM™ allows the user to manage system peaks through
  - Electric rates to send price signals to manage load
    - Static and dynamic rate design
    - Behavioral change, technology adoption, or both
  - Directly manage load through flex capacity
  - Controllable flex load “calls”, timing and duration



VERMONT RATE DESIGN INITIATIVE

LSAM™ UPDATE – SINCE LAST STAKEHOLDER MEETING

- Technical Working Group (TWG) call 4/28/2020
  - Follow-up development of LSAM demo video
    - https://youtu.be/vTn-w7i9Jko
- Solicited and received feedback from TWG on questions on how the model functions and on results coming out of the model
- Feedback has been reviewed, and will be incorporated in the language and modeling results conveyed in NewGen report

VERMONT RATE DESIGN INITIATIVE

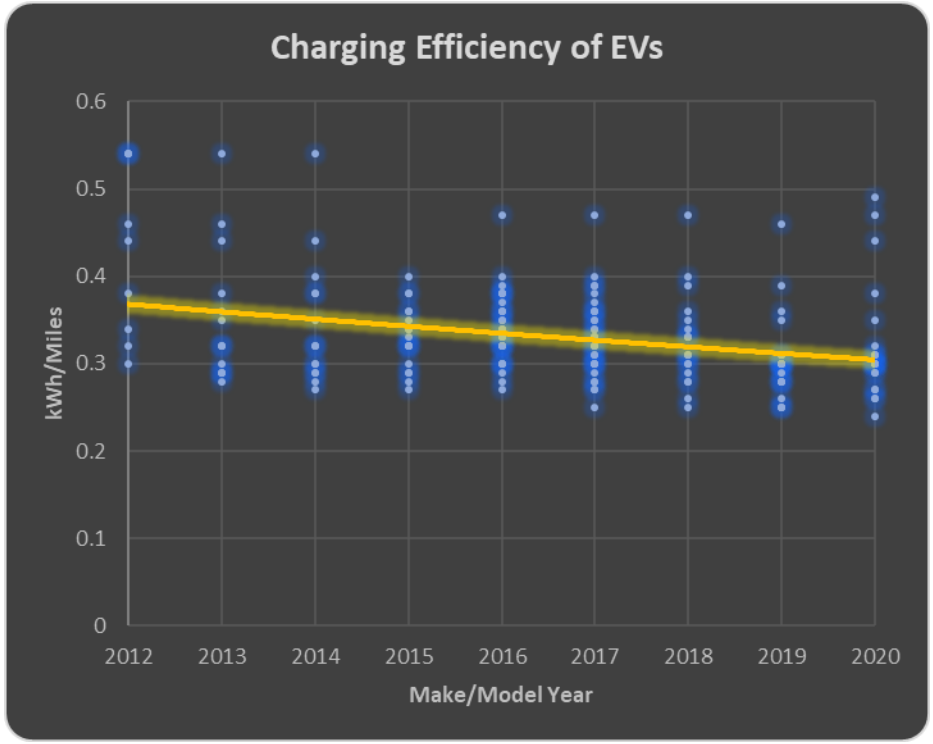
LSAM™ UPDATE – FEEDBACK FROM TWG ON EVS

- Feedback from TWG primarily on EV assumptions and impacts
  - Fixed some issues w/ data labels
  - Comments on EV growth
    - Linear vs. exponential to reflect actuals to-date
  - Question on total EV kWh energy per vehicle
    - LSAM EV charging profile comes from National Household Transportation Survey
      - Northeastern Metropolitan locations <1M people without mass transit
    - Vehicle mileage in NHTS is higher than GMP's vehicle data
      - ~12,550 miles/yr in LSAM/NHTS vs. 10,900 miles/yr from GMP
        - » LSAM is overstating energy consumption of EVs, but not necessarily demand
        - » Issue to be noted in NewGen report

VERMONT RATE DESIGN INITIATIVE

LSAM™ UPDATE – FEEDBACK FROM TWG ON EVS

- EV charging efficiency
  - Model assumes constant 0.313 kWh/mile
    - Provided by VEIC as a blended average charging efficiency for the state in 2019 (AEV/PHEV split)
  - Efficiency may evolve with
    - Charging efficiency
    - Model availability impacts
  - GMP notes vehicle charging efficiency fluctuates w/ weather
    - LSAM modeled constant charging efficiency for all seasons/months resulting in energy consumption
      - Under-estimated in hot and cold months
      - Over-estimating in shoulder season
    - Issue to be noted in report



FuelEconomy.gov: https://tinyurl.com/y7tydwht

VERMONT RATE DESIGN INITIATIVE

LSAM™ UPDATE – FEEDBACK FROM TWG ON EVS

- EV load/charging profile
  - There are differences between LSAM/NHTS driving data and GMP's actual metered EV load
  - LSAM/NHTS EV load peaks earlier in the day (~4-6pm) than GMP's data (8pm-10pm)
    - Differences in modeled to actual future EV charging will drive different impacts on peak demand
      - Lower non-EV load in evening
      - Availability of PV to offset EV charging
  - At-Work charging assumptions
    - Assumed EVs charged At-Work also charge At-Home
    - Count of NHTS vehicle trips ending at work
  - NewGen will note these issues in our report

	Delta +/-			
	Summer		Winter	
	Weekday	Weekend	Weekday	Weekend
0:00	-7%	-4%	-6%	-3%
1:00	-6%	-6%	-5%	-6%
2:00	-5%	-4%	-4%	-4%
3:00	-4%	-3%	-3%	-3%
4:00	-3%	-2%	-3%	-2%
5:00	-2%	-1%	-2%	-1%
6:00	-2%	-1%	-2%	-1%
7:00	-1%	0%	-2%	-1%
8:00	0%	0%	-1%	-1%
9:00	1%	1%	0%	1%
10:00	2%	1%	1%	1%
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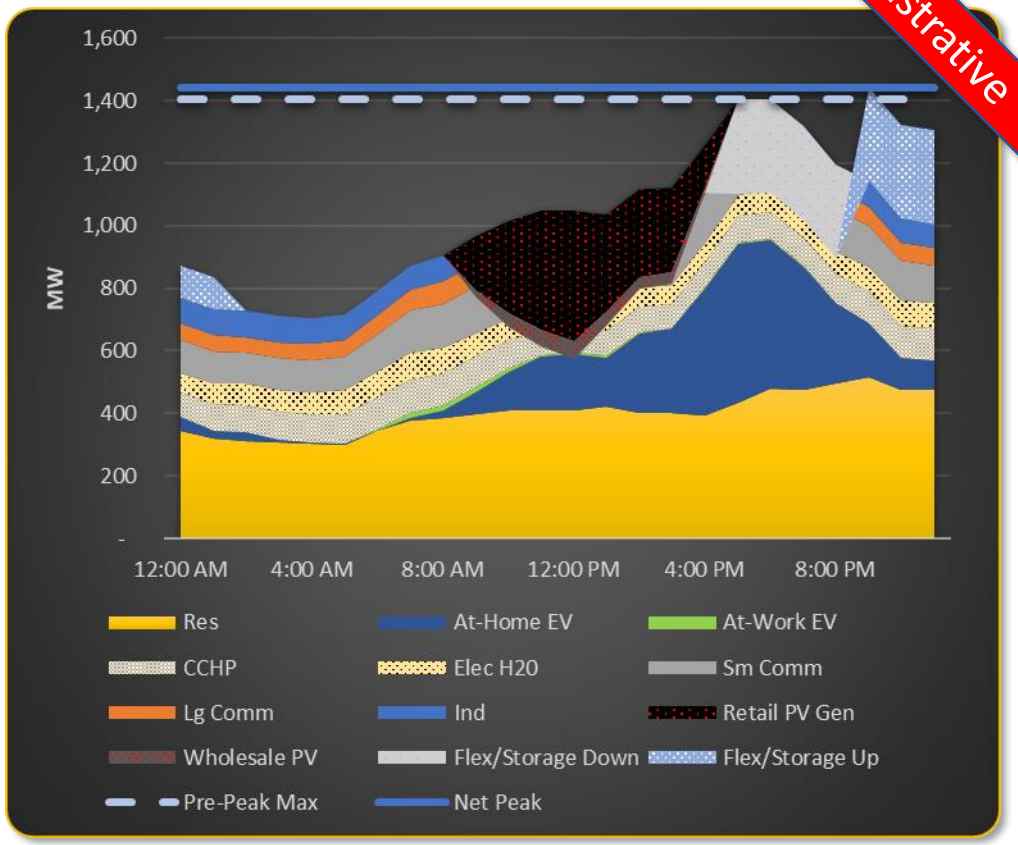
12:00	3%	5%	3%	5%
13:00	2%	3%	2%	3%
14:00	4%	4%	4%	3%
15:00	4%	3%	4%	2%
16:00	7%	3%	7%	3%
17:00	9%	2%	9%	2%
18:00	7%	3%	6%	2%
19:00	3%	0%	2%	0%
20:00	0%	-2%	-1%	-3%
21:00	-3%	-2%	-3%	-1%
22:00	-5%	-2%	-5%	0%
23:00	-5%	-2%	-5%	-1%

Analysis from GMP:
Percentages representing LSAM load / GMP metered EV load

VERMONT RATE DESIGN INITIATIVE
LSAM™ UPDATE – ADDITIONAL FEEDBACK FROM TWG

- Flexible Load Snapback
  - GMP noted that managing "snapback" of controlled loads becomes more complex with greater capacity under management
    - Load shaping vs. load curtailing to avoid new peaks
    - Tranches of capacity, staggered CPP/TOU periods, etc.
- Distribution cost impacts
- Issues raised by the TWG will be outlined in NewGen report



Example w/ 300 MW of EV load "snapping back"

PANEL DISCUSSION #1 –
POTENTIAL AREAS FOR RECOMMENDATIONS

- Scott Burnham (NewGen) – Moderator
- Rick Weston (RAP)
- Jeff Monder (GMP)
- Paul Hines (Packetized Energy, U. of Vermont)
- Freddie Hall (BED)

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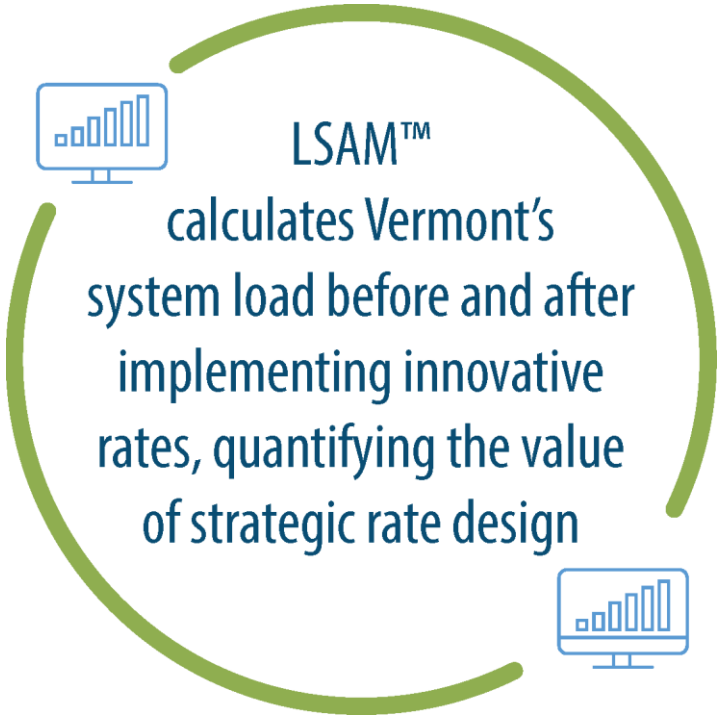
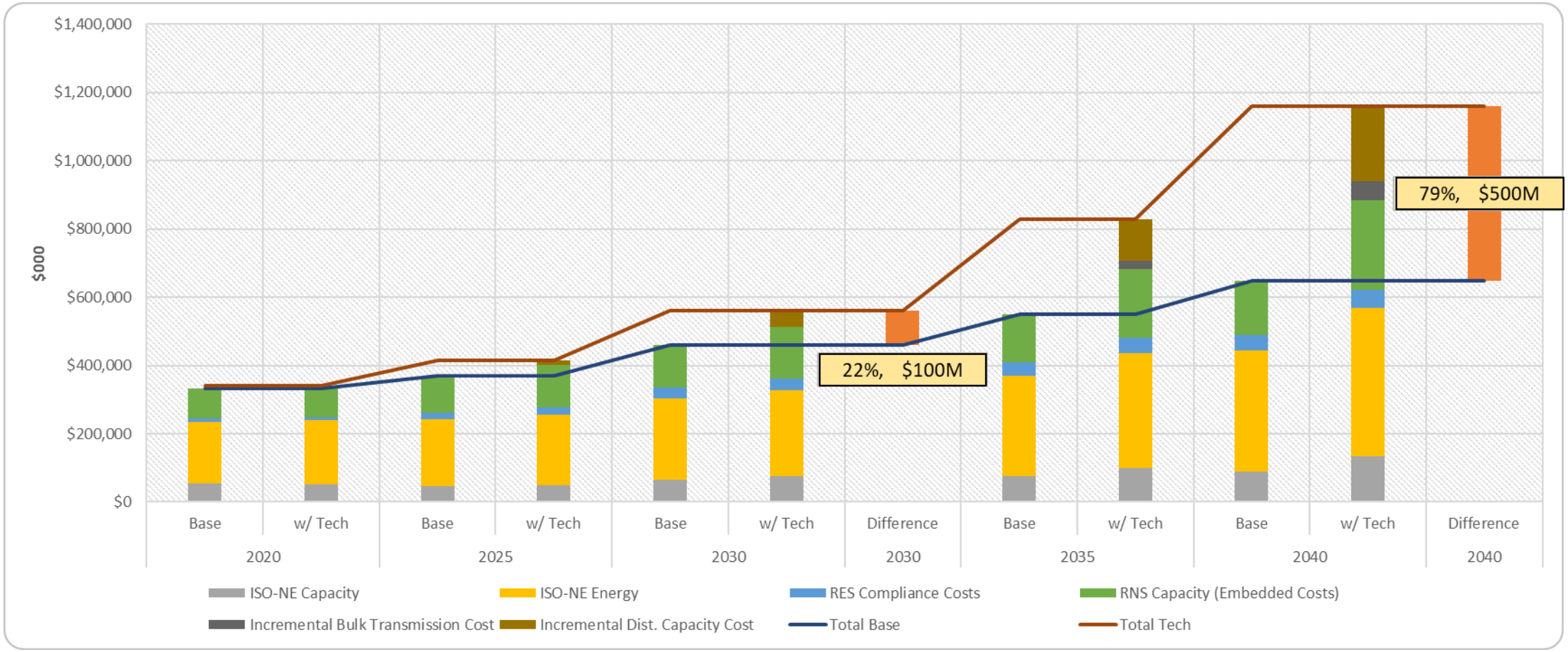


COMPARISON BETWEEN MODELED SCENARIOS

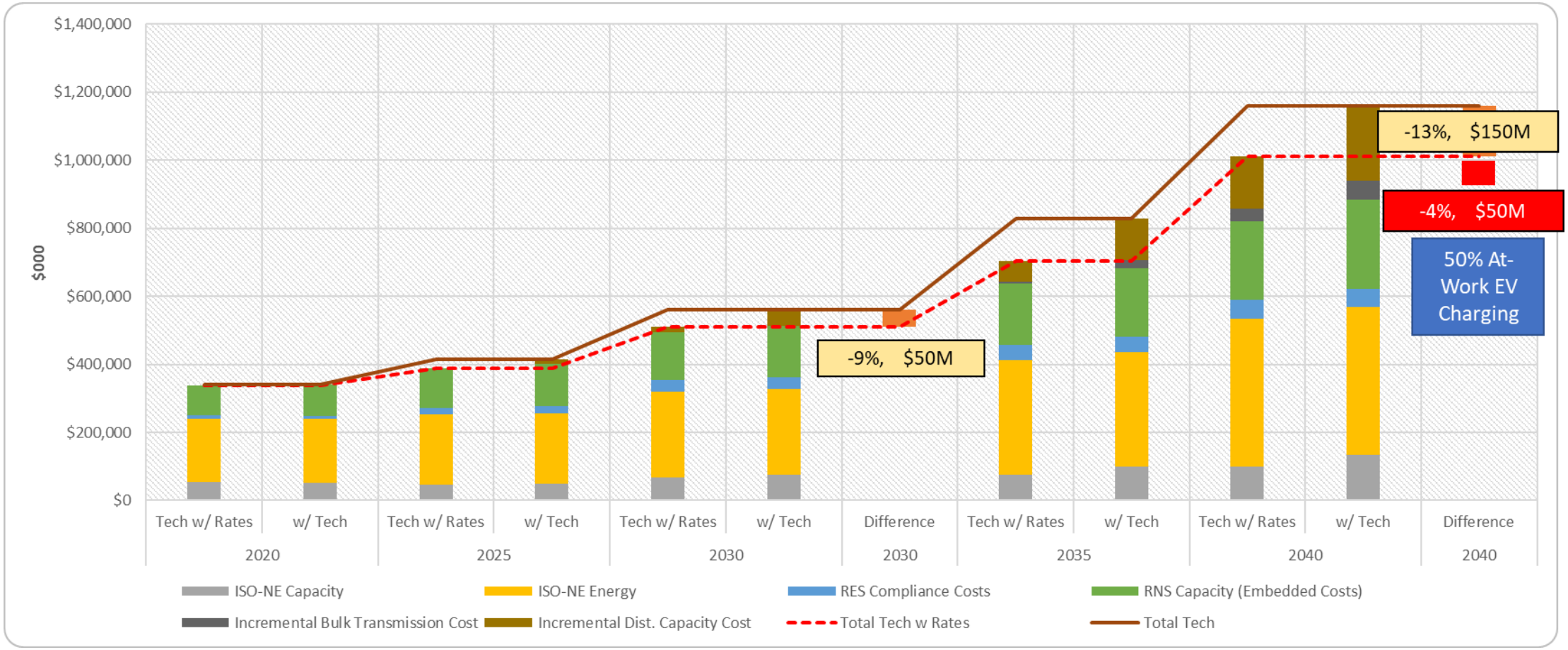
BASELINE VS. INCLUDING TECHNOLOGY ADOPTION - 2040



Upward Pressure

COMPARISON BETWEEN MODELED SCENARIOS

TECHNOLOGY ADOPTION FUTURE VS. TECH W/ RATES, AT-WORK EV - 2040

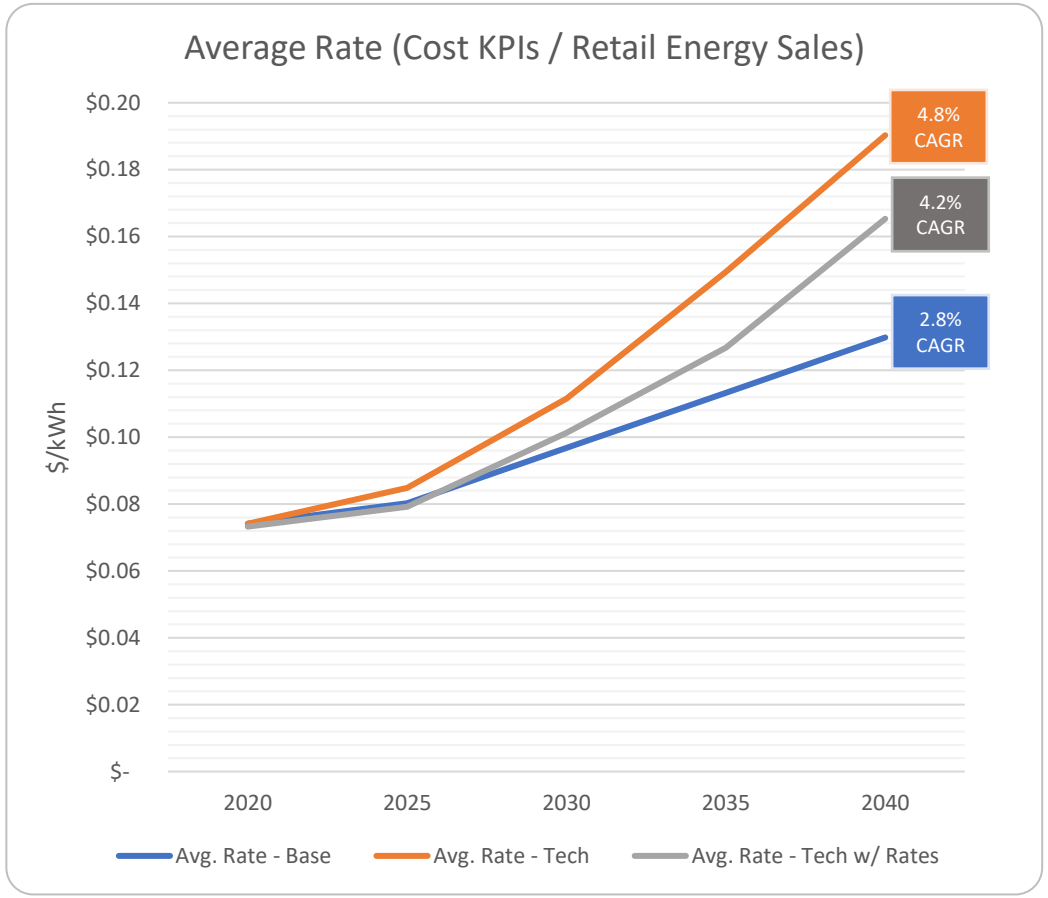


Downward Pressure

LSAM MODELED RATE PRESSURE

BEFORE AND AFTER STRATEGIC RATE DESIGN

- Electric market evolution will exert upward rate pressure
  - CAGR of 4.8% vs. 2.8% (Base)
- Innovative rates can send price signals for customers to change usage and manage costs
  - Initial modeled savings $150M-$200M



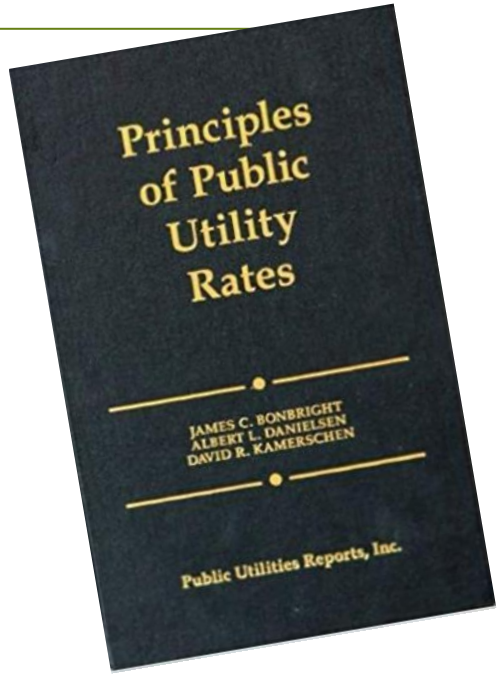
LSAM MODELED RATE PRESSURE AS AN INPUT TO DEVELOPING RECOMMENDATIONS FOR THE FUTURE

- LSAM™ is a tool to be used to provide insight into indicative forecasts and impacts of an evolving Vermont electric market
  - LSAM™ to facilitate quantifying differences in long-term views
- The exact magnitude and timing of future impacts varies with one's view of the future and corresponding input assumptions
  - But EVs and other electrification are expected to drive new load, new peaks, and new costs
    - Innovative rate design and direct control of end-use load can manage these impacts

INNOVATIVE ELECTRIC RATE DESIGN

FOUNDATIONAL GOALS OF RATE DESIGN IN GENERAL

- Bonbright's Principals of Utility Rate Making
  - Practical
  - Uncontroversial as to interpretation
  - Meet revenue requirement
  - Revenue stability
  - Rate stability
  - Fairness among customers
  - Avoidance of undue discrimination
  - Economic efficiency
- As the electric industry evolves, rate design can and should be viewed as more than just a backwards-looking accounting exercise



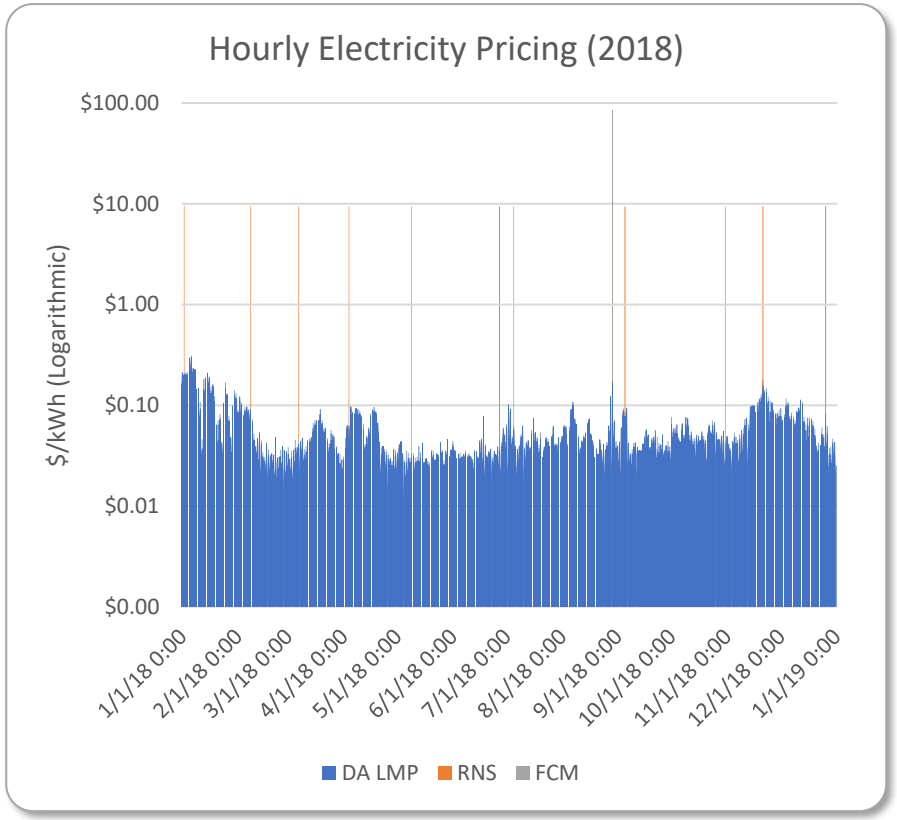
"Rates as a Resource"

Electric rates can be a forward-looking tool sending price signals to end-use customers to recover *and manage* electric system costs

INNOVATIVE ELECTRIC RATE DESIGN

HOURLY AND MARGINAL VS. EMBEDDED COST OF SERVICE

- Total electric system costs are a function of electric consumption during all hours
  - But some hours are more costly than others
- Innovative rate design informed by marginal costs serves a dual purpose:
  - Improves equity in aligning with cost causation
  - Signals the customer to change usage patterns
- Marginal cost analyses can inform incentives for customer behavior change



Vermont operating in an RTO/ISO market makes marginal cost analysis substantially easier

INNOVATIVE ELECTRIC RATE DESIGN

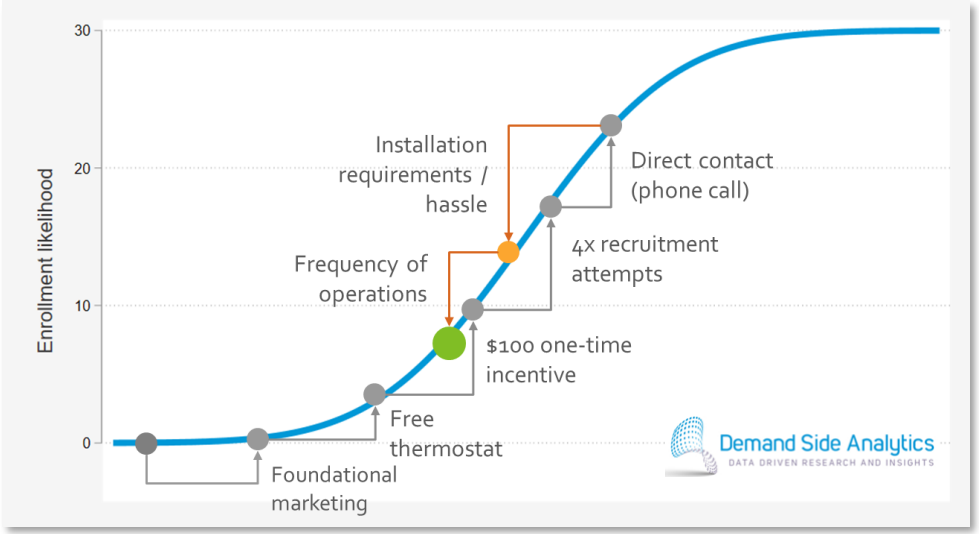
INDIRECT AND DIRECT LOAD CONTROL

- Utilities can manage load indirectly or directly
  - Indirect: Better align substantial pricing differentials in certain hours of the year with rate design, incenting customer behavior and/or technology adoption to shift load
    - Or the customer will pay more for load during expensive hours
  - Direct: Utility may directly control (curtail) the customer's load, turning down during expensive hours, in exchange for a payment or other incentive
- The efficacy of each type of program is largely a function of enrollment

INNOVATIVE ELECTRIC RATE DESIGN

IMPLEMENTATION AND ENROLLMENT CHALLENGES

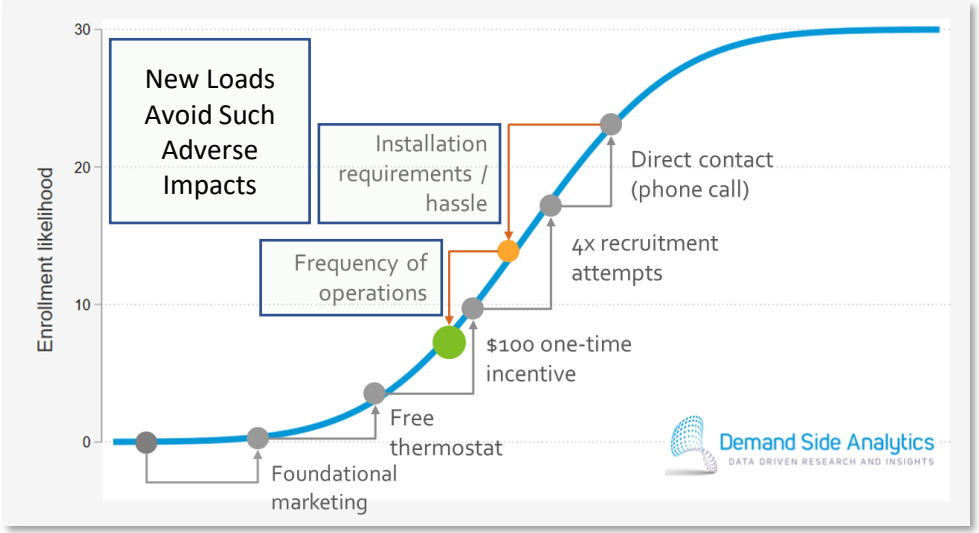
- To be effective, innovative rate design offerings must have
  - Customer enrollment and
    - Customer behavior change or
    - Increased customer electric bills
- Enrollment in innovative rate design offerings is deterred by both
  - Increased frequency of behavior change and
  - Risk of higher electric bills deter enrollment
- Enrollment is also a function of utility marketing and available incentives
  - May be improved with regulatory encouragement



INNOVATIVE ELECTRIC RATE DESIGN

IMPLEMENTATION AND ENROLLMENT CHALLENGES

- Old static TOU rates with low customer enrollment:
  - Not typically actively marketed by the utility
  - Applied to an entire household/business load
    - Requiring substantial frequency of operations or installation of substantial new tech
- Certain types of newer loads
  - Do not require frequent behavior change (*Set it and forget it!*)
  - Do not require substantial new tech
  - Can be very responsive to pricing signals



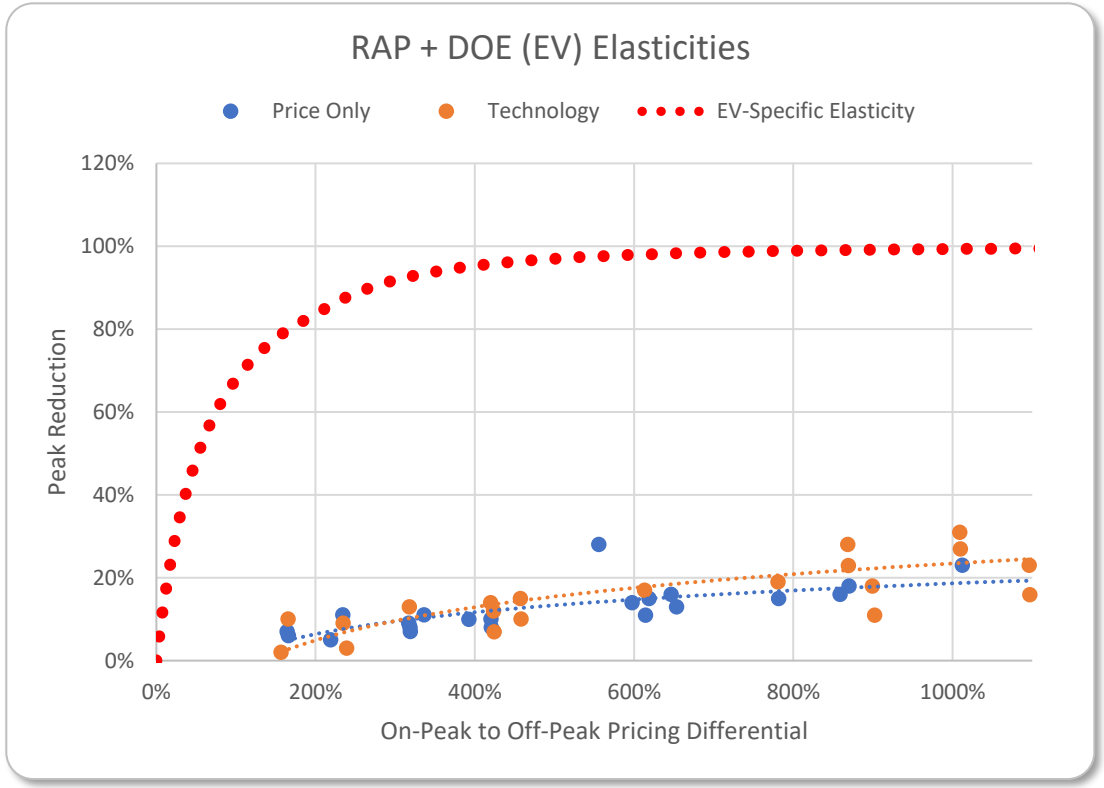
Time-differentiated rate design is not a new concept . . .
We've had a TOU rate for years and nobody's on it

INNOVATIVE ELECTRIC RATE DESIGN

END-USE DIFFERENTIATED ELECTRIC RATE DESIGN

- Certain loads can be “turned down”* with minimal impact to customer
  - EV charging
  - Heat pump water heaters
  - Others (commercial opportunities?)
- Importance of “consumer comfort”
  - Will a targeted change to usage be “felt” by the customer?
    - Turning down heating/cooling during the coldest/hottest hours of the year

* By the customer and/or directly by the utility



One of these things is not like the other…

INNOVATIVE ELECTRIC RATE DESIGN

END-USE DIFFERENTIATED ELECTRIC RATE DESIGN

- Electric rates can be targeted at certain electric end-uses
  - Programmable loads with a defined duration that can be completed in the off-peak periods may be managed with static TOU
    - Electric vehicle charging
    - Heat pump water heaters?
  - Loads varying with weather may be better managed with dynamic rates (CPP, RTP) or direct load control
    - Space conditioning
      - Enrollment in CPP/RTP may be limited due to “customer comfort” factor
      - Utility-controlled space heating/cooling may be cycled to manage peak with limited impacts to “customer comfort”

INNOVATIVE ELECTRIC RATE DESIGN

UTILITY MARKETING AND IMPLEMENTATION

- Utilities should market innovative rate programs to customers making certain purchases
  - Partnerships with device vendors offering programs that save the customer money
- Where incentives are offered to the customer, utilities should require enrollment (mandatory or opt-out)
  - EV charger incentives
  - Smart thermostats
  - Other energy efficiency incentives, etc.
- In other opportunities of consumer education or communication, such programs should be advertised and the benefits made clear

INNOVATIVE ELECTRIC RATE DESIGN

NEW BUSINESS MODELS AND THE ROLE OF 3RD PARTIES

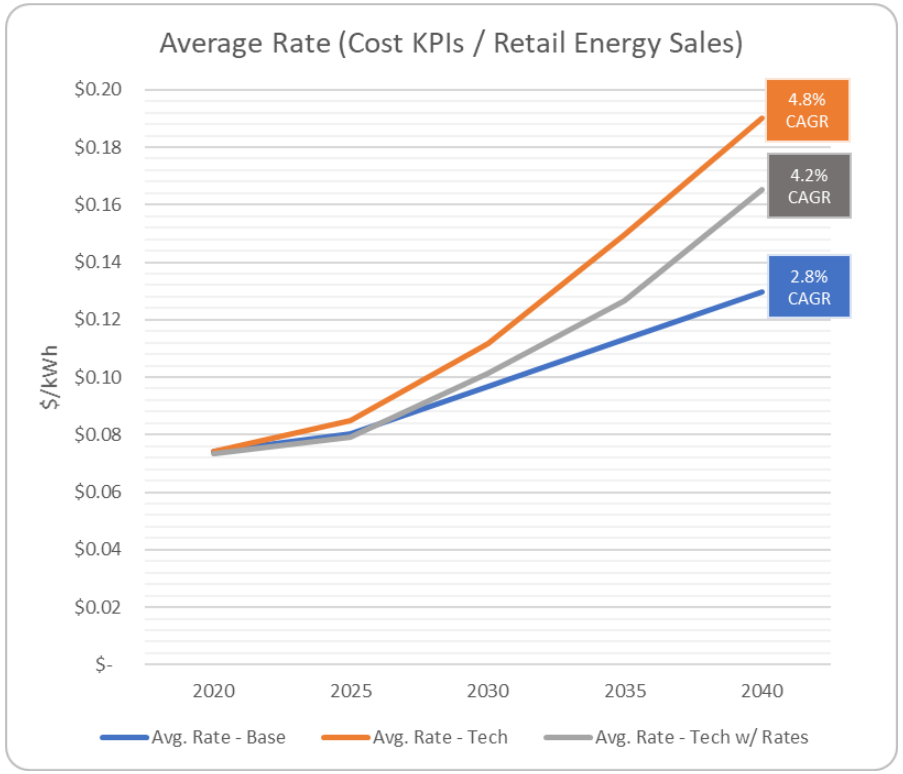
- As technology evolves and where there is mutual benefit to the customer and the utility, look to new models of service
  - Utility vs. 3rd party offering
  - Fixed fee(s) for service offering a total cost reduction with direct load management responding to dynamic utility cost drivers

DRAFT STUDY CONCLUSIONS AND RECOMMENDATIONS

MAY 21, 2020

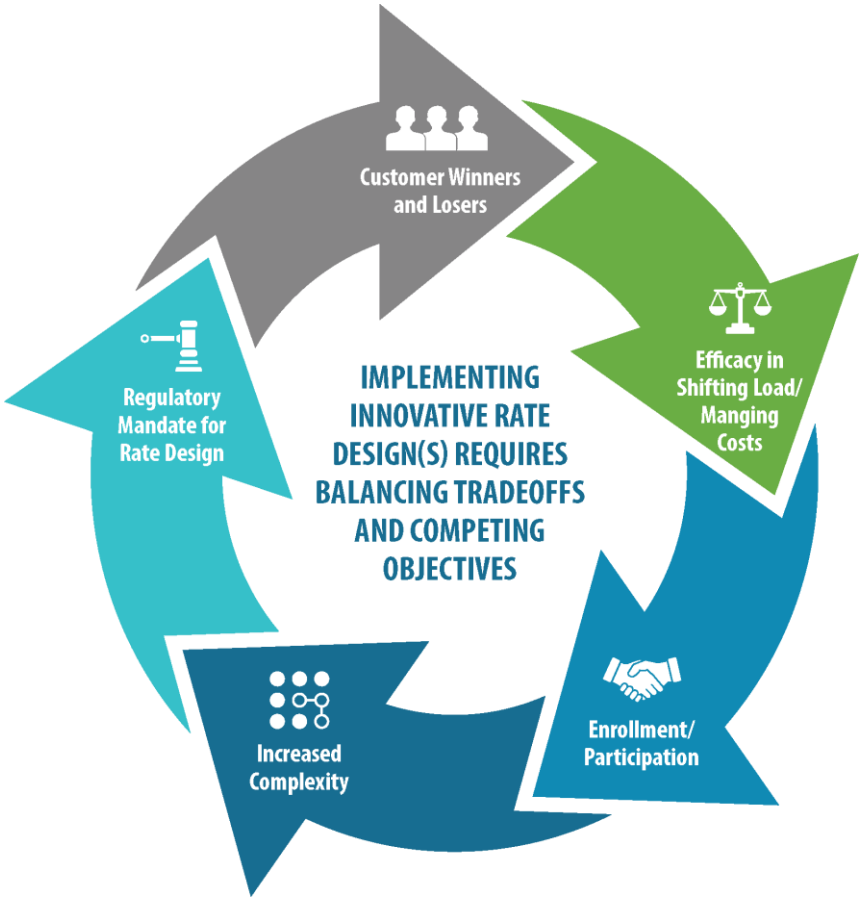
DRAFT STUDY CONCLUSIONS AND RECOMMENDATIONS

- There is likely to be (substantial) upward rate pressure in the future from increased adoption of
  - PV
  - EVs
  - Cold Climate Heat Pumps
  - Heat Pump Water Heaters
  - Other electric technologies



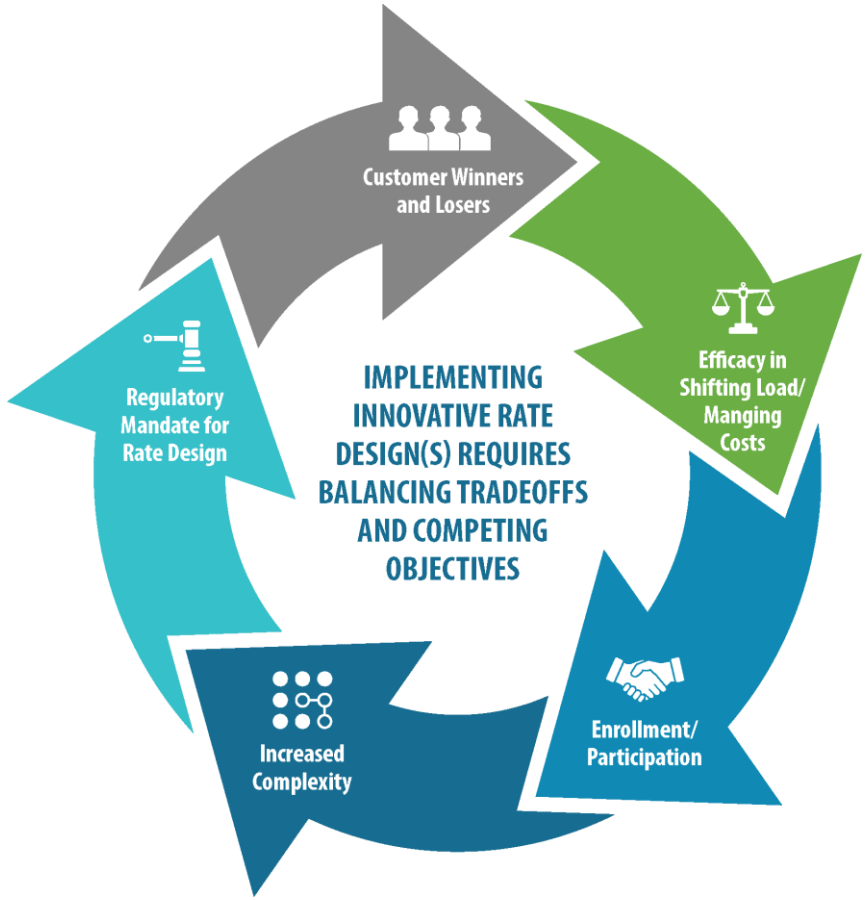
DRAFT STUDY CONCLUSIONS AND RECOMMENDATIONS

- Electric rates should create stability, equity, and recover costs
  - but can be used as a resource in managing costs
- Rates can better align with time-differentiated cost drivers to incent behavior or tech adoption improving system costs
  - Detailed analyses of cost drivers
    - Simplified by Vermont's participation in ISO market



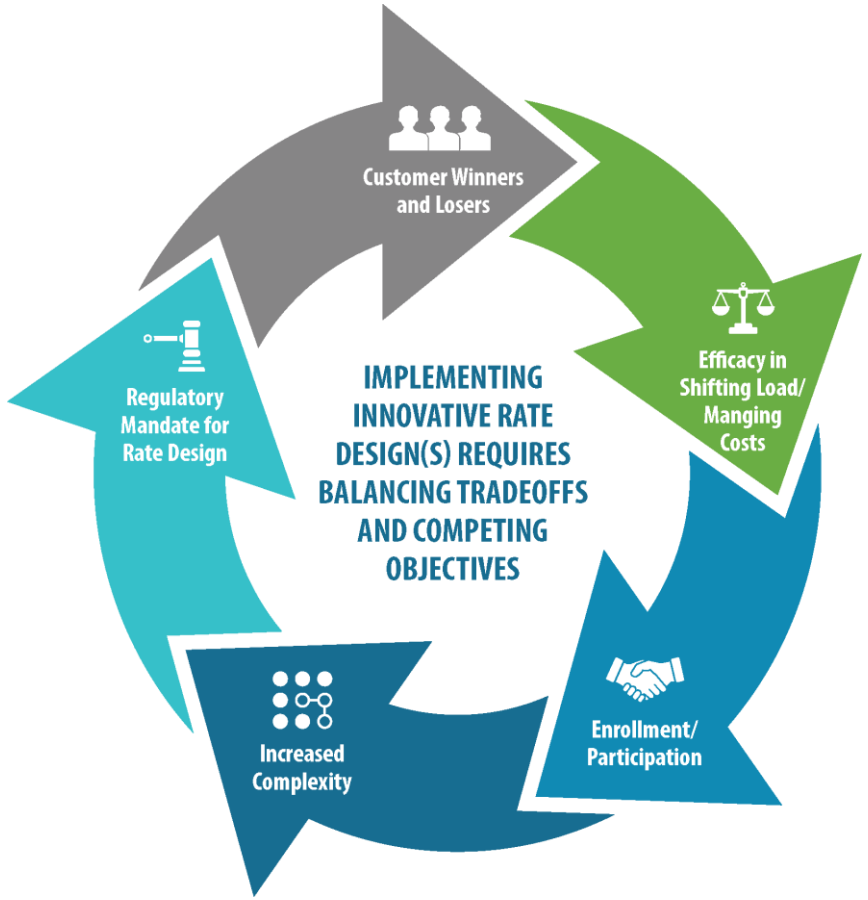
DRAFT STUDY CONCLUSIONS AND RECOMMENDATIONS

- Utilities should tailor innovative rate offerings to specific end-use technologies
  - More “bang for the buck” in targeting loads that can easily change and thus reduce peak
  - Improves customer enrollment by avoiding substantial behavior change/tech installation
  - Acknowledge importance of “customer comfort” in seeking behavior change



DRAFT STUDY CONCLUSIONS AND RECOMMENDATIONS

- Utilities should actively market enrollment in innovative rate offerings
  - In exchange for incentives, encourage (mandate or opt-out) enrollment
  - Otherwise leverage consumer communication or education on benefits (savings) of enrollment



DRAFT STUDY CONCLUSIONS AND RECOMMENDATIONS

- Look to new business/service models and partnerships as technologies evolve
  - Example: Flat fee service at a reduced total cost in exchange for direct load control
    - Utility vs. 3rd part management